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GAIN SATURATION STUDIES IN LG-750 AND LG-770 AMPLIFIER GLASS

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Experiments were performed on the 100-J class Optical Sciences Laser (OSL) at LLNL to characterize the saturation fluence and small-signal gain of a solid-state Nd:glass amplifier utilizing LG-750 and the proposed amplifier glass for the National Ignition Facility (NIF), LG-770. These high quality measurements of gain saturation at NIF level fluences, i.e., 10-15 J/cm^2, provide essential parameters for the amplifier performance codes used to design NIF and future high power laser systems.

The small-signal gain, saturation fluence and square-pulse distortion were measured as a function of input fluence and pulse length in platinum-free LG-750 and LG-770. The 1053-nm input beam was produced by a Q-switched Nd:YLF oscillator. Pulses ranging from 1 - 17 ns were sliced from the 100-ns envelope by a Pockels cell and amplified to provide an input fluence of up to 6 J/cm^2 in a 1.28 cm^2 aperture at the input to the test amplifier. The input fluence, output fluence, small-signal gain and passive losses were measured to allow calculation of the saturation fluence. Fast photodiode traces provided a record of temporal pulse distortion due to gain saturation. A small fraction of the main pulse, split off early in the OSL amplifier chain, provided a weak small-signal gain probe 40 ns before the arrival of the main extraction pulse. This technique provides a precise background-free measurement of the small-signal gain with immunity to the noise that complicated previous[1] measurements.

Least squares fits of the output vs. input fluence data using a Frantz-Nodvik[2] model was used to obtain an average saturation fluence for each data set. These fits deviate from the data at high fluence as the saturation fluence increases linearly as a function of output fluence. This is because each ion in a glass sees a slightly different crystal field, thus the cross section and saturation fluence are really ensemble averages. By assuming there are multiple ion sites in the material, the data can be modeled more accurately.[3] While this method does not produce a unique solution, it does provide a more accurate model for predicting gain saturation in an amplifier code. Overall, gain saturation in LG-750 and LG-770 is comparable at long pulse lengths. For shorter pulse lengths, < 5 ns, LG-770 exhibits a stronger pulse length dependence than LG-750, possibly due to a longer terminal level lifetime. LG-770 also has a higher cross-section, which is reflected by its slightly higher extraction efficiency.

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